

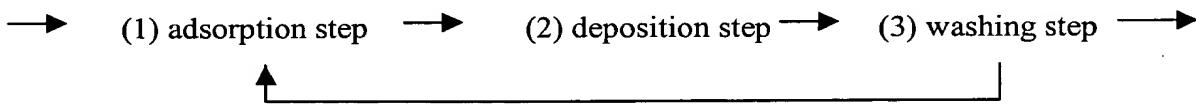
contain new matter within the meaning of 35 USC §132. In view of the above amendments and the following remarks, reconsideration is respectfully requested.

Claim 1 stands rejected under 35 USC §102(b) as anticipated by or, in the alternative, under 35 USC §103(a) as obvious over International Publication No. WO 97/26039 to Shahinpoor et al. (hereinafter "Shahinpoor"). Additionally, claim 1 has been rejected under 35 USC §103(a) as being unpatentable over U.S. Patent No. 5,268,082 to Oguro et al. (hereinafter "Oguro") in combination with U.S. Patent No. 4,804,592 to Vanderborgh et al. (hereinafter "Vanderborgh"). Each of these rejections is respectfully traversed.

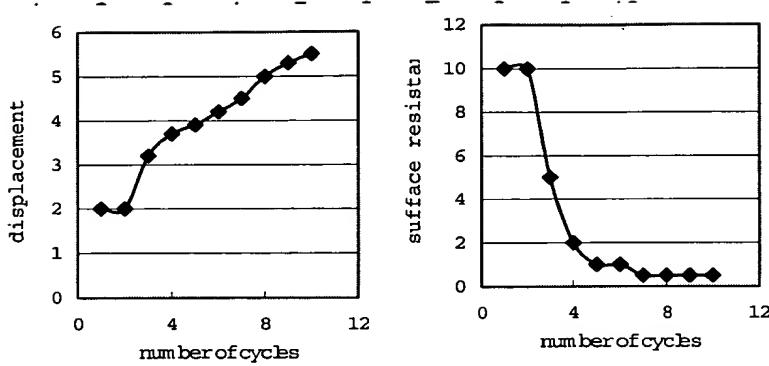
As the Examiner is aware, the present invention is directed to a process for producing an actuator element. Specifically, in the process of the present invention, metal electrodes are formed on an ion-exchange resin by repeating the following steps:

- (i) a step of allowing the ion-exchange resin product to adsorb a metal complex in an aqueous solution (adsorption step),
- (ii) a step of reducing the metal complex adsorbed on the ion-exchange resin product by a reducing agent to deposit a metal on the surface of the ion-exchange resin product (deposition step), and
- (iii) a step of washing the ion-exchange resin product having the deposited metal (washing step).

These steps of adsorption, deposition, and washing are repeated for a period of 4 to 9 cycles. In particular, in formation of a metal electrode on the ion-exchange resin, the steps of adsorption, deposition and washing are repeated 4 to 9 times according to the following scheme:



As discussed in the specification, repeating these steps increases the contact angle between the ion-exchange resin product and the metal electrode, thereby increasing the quantity of ions migrating to the electrode, and increasing the thickness of the metal electrode. Such an increase in the thickness of the metal electrode reduces the surface resistance of the electrode, thereby improving the conductivity thereof. As such, the polymeric actuator prepared according to the method of the present invention obtains a high degree of bending (deformation or degree of displacement), and therefore exhibits quick response. Moreover, since the adsorption, deposition, and washing steps are repeated for 4 to 9 cycles, the actuators prepared according to the method of the present claim exhibit optimum displacement quantity and lower surface resistance. In particular, as seen through the results demonstrated in Examples 1-9 and comparative Example 1 discussed at pages 36-41 of the application, when a number of cycles of repetition of the adsorption, deposition, and washing steps is 3 or less, the actuators do not exhibit optimum displacement quantity nor significantly reduced surface resistance. Moreover, it is recognized through the present invention that even if the number of cycles of the adsorption, deposition, and washing steps is ten or more, the actuator may exhibit improved properties, however, manufacture of the actuator becomes inefficient due to the time and cost of repetition of such steps. Accordingly, repeating the adsorption, deposition, and washing steps for a period of 4 to 9 cycles achieves optimum properties, as set forth through the following graphs, which plot the values of displacement and surface resistance as seen through Examples 1-9 and comparative Example 1 discussed in the application:



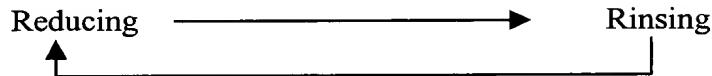
Turning to the rejection of the claims, the Examiner contends that Shahinpoor teaches preparing actuators by conducting the adsorption, deposition, and washing steps of the present claims. Moreover, the Examiner contends that the option of changing the order and/or repeating the steps are disclosed through Shahinpoor.

Shahinpoor discloses a method for creating an actuator consisting of an ion-exchange material. In Shahinpoor, the electrode formation process includes a) rinsing an ion-exchange material; b) coating the ion-exchange material with a substance which undergoes chemical reduction in the presence of a reducing agent; and c) reducing the coating on the ion-exchange material by exposing the ion-exchange to a reducing agent. Nothing in Shahinpoor, however, teaches or suggests repeating the steps of adsorbing a metal complex, reducing the metal complex for deposition, and washing the ion-exchange resin having the deposited metal.

In support of the rejection, the Examiner references various portions of Shahinpoor which disclose repeating various steps of the process disclosed in Shahinpoor. For example, the Examiner contends that page 5, lines 6-30 teaches changing the order and/or repeating steps. Page 5, lines 22-24 of Shahinpoor, however, merely teaches that the

reducing and the rinsing may be repeated, followed by a final rinsing step in water.

Accordingly, Shahinpoor teaches at most the following scheme:



Clearly, these teachings of Shahinpoor fail to disclose or suggest repeating the coating step, or adsorption step, as is clearly required in the claim of the present invention.

Moreover, the Examiner contends that Shahinpoor teaches changing the order and/or repetition of steps at pages 6 and 7. Page 6, line 24, through page 7, line 11 of Shahinpoor discloses the following steps:

Roughening step of the ion-exchange material → **First step of cleaning** →
First step of rinsing → **First step of boiling** → **Second step of rinsing** →
Second step of boiling → **Coating step** → **Third step of rinsing** →
First step of reducing → **(simultaneously heating and stirring)** → **Fourth step of rinsing** →
First step of storing → **Fifth step of rinsing** → **Second step of reducing** →
Simultaneously heating and stirring → **at least one step of rinsing** →
Second step of cleaning → **Second step of storing**.

Shahinpoor notes at page 7, lines 11-13 that the steps are preferably performed in the above order, and indicates that the last four steps can be repeated and include a final rinsing step prior to the second storing step. Such teachings merely disclose that the steps of storing, rinsing, reducing, and cleaning may be repeated. Again, nothing in the Shahinpoor reference teaches or remotely suggests that the coating step, namely the adsorption step, may

be repeated, let alone that the steps of adsorption, deposition, and washing may be repeated for a cycle of 4 to 9 times, as set forth in the present claims.

As noted above, repetition of the adsorption, deposition, and washing steps leads to the contact area between the ion-exchange resin product and the metal electrode having an increased surface area, thereby causing the quantity of ions migrating to the electrode to be increased, as well as the thickness of the metal electrode increased.

To establish a *prima facie* case of obviousness of a claimed invention, all of the claim limitations must be taught or suggested by the prior art. MPEP 1243.03, citing *In Re Royka*, 490 F2d 981, 180 USPQ 580 (CCPA 1974). Clearly, nothing in the teachings of Shahinpoor discloses repeating each of the adsorption step, deposition step, and washing step. Moreover, Shahinpoor fails in any way to suggest the desirability of repeating each of the adsorption step, deposition step, and washing step. In fact, Shahinpoor teaches away from the present invention by suggesting that the reduction step and the washing step may be repeated, without alluding to any repetition of the adsorption step. Accordingly, it is apparent that Shahinpoor fails to teach or suggest repeatedly conducting each of the adsorption step, deposition step, and washing step. Shahinpoor therefore fails to anticipate or render the present claim obvious. Accordingly, withdrawal of the rejection based on the teachings of Shahinpoor is appropriate and is respectfully requested.

Moreover, the combination of Oguro and Vanderborgh also fails to teach or suggest the repetition of the adsorption step, deposition step, and washing step according to the present invention.

In particular, Oguro discloses the formation of platinum or gold electrodes on an ion-exchange membrane. Oguro teaches that the electrode material can be attached to the ion-exchange membrane by a number of various methods including chemical plating, electro-plating, vacuum deposition sputtering, coating, pressure adhesion or the like. Vanderborgh

teaches depositing metals onto electrode substrates such as ion-exchange resins with moderate reducing agents such as hydrazine.

The combination of Oguro and Vanderburgh fails to teach repeating an adsorption step, a deposition step, and a washing step, let along repeating such steps for a cycle of 4 to 9 times, as is clearly required by the claims of the present invention. In fact, the Examiner recognizes such deficient teachings in the Office Action, where it is noted that "Oguro fails to disclose instant step (ii), i.e., depositing a metal on the surface on an ion-exchange resin by reduction." Moreover, the Examiner indicates that Applicants' arguments that Oguro and Vanderburgh fail to teach repeatedly conducting the adsorption, deposition and washing steps are not persuasive, in that "one of ordinary skill in the art would understand from the totality of the information conveyed by the references to repeat the steps according to the area and thickness of the coating desired according to the need at hand because that is the state of the art." In fact, the Examiner specifically notes that "while neither reference discloses repeating the instant process steps the Examiner takes official notice that coating procedures of the type described by the references typically rely on repeated applications and/or control of application time and flux, i.e., concentration of metal, to obtain the coating coverage desired." In support of this official notice, the Examiner refers to Shahinpoor at page 5, line 27 through page 6, line 2. As previously discussed, however, Shahinpoor also fails to disclose repeating the instant process steps of adsorption, deposition, and washing. As such, the Examiner has failed to provide any support for the position that coating procedures involving repetition of adsorption, deposition, and washing, is well-known and represents the state of the art, as contended in the Office Action.

Moreover, the Examiner specifically notes that "it is well settled that process variables relating to reaction conditions not disclosed directly by either reference are within the broad teaching of the prior art which absent the showing of unexpected result(s) are not

deemed to impact patentability." The Examiner further notes that in the present case, "all the claimed process steps are known and nothing on this record shows criticality for repeating the steps for the purpose of realizing a new or unexpected result versus performing the same steps for extended periods of time or with more concentrated complex solutions." To the contrary, the Examples of the present application, as discussed above, clearly demonstrate the improved results seen in the displacement and the surface resistance as seen through repetition of the adsorption, deposition, and washing steps. While Examples 1-9 do not specifically provide for comparison with a process involving performing the same step for an extended period of time or with a more concentrated complex solution, the Examiner has failed to provide any reference which demonstrates improved results seen through performing the steps for extended periods or with more concentrated complex solutions. Accordingly, such a demonstration of criticality of the present invention vs. such other processes is not warranted.

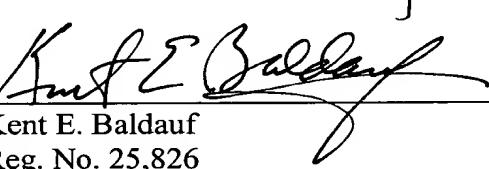
Clearly, as seen through the above remarks, none of the prior art references disclose or suggest the process of the present invention which involves repeatedly conducting the steps of adsorption, deposition, and washing, let alone for a cycle of 4 to 9 times. At most, the Shahinpoor reference teaches repeating a portion of these steps, namely the reduction and rinsing step, and as recognized by the Examiner, Oguro and Vanderborgh fail to teach or disclose repeating any of the processing steps. Accordingly, the rejection of claim 1 based on any of these references, whether considered alone or in combination, is improper. Withdrawal of the rejections based on these references is respectfully requested.

In view of the above remarks, withdrawal of the rejection and favorable reconsideration are respectfully solicited. Should the Examiner have any questions regarding any of this information, the Examiner is invited to contact Applicants' undersigned representative by telephone at 412-471-8815.

Respectfully submitted,

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MARKED UP VERSION OF THE CLAIM

1. (Amended) A process for producing a polymeric actuator comprising an ion-exchange resin product and metal electrodes which are formed on the surface of the ion-exchange resin product and are insulated from each other, said actuator operating as an actuator by applying a potential difference between the metal electrodes when the ion-exchange resin product is in the water-containing state to allow the ion-exchange resin product to undergo bending or deformation,

wherein the following steps (i) to (iii) are repeatedly conducted to form the metal electrodes ranging from the surface of the ion-exchange resin product to the inside thereof;

(i) a step of allowing the ion-exchange resin product to adsorb a metal complex in an aqueous solution (adsorption step),

(ii) a step of reducing the metal complex adsorbed on the ion-exchange resin product by a reducing agent to deposit a metal on the surface of the ion-exchange resin product (adsorption step),

(iii) a step of washing the ion-exchange resin product having the deposited metal (washing step),

the number of cycles of the above steps is in the range of 4 to 9.